REVIEWS

Fire in South African mountain fynbos. Ecosystem, community and species response at Swartboskloof. Edited by B. W. VAN WILGEN, D. M. RICHARDSON, F. J. KRUGER, H. J. VAN HENSBERGEN. 1992. Springer-Verlag, New York, Berlin, Heidelberg. xxi + 325 pages. $138, ISBN 0-387-53301.

Cursed by the difficulty of replication at the large scale that the study of many important questions demands, ecologists must of necessity look to independent studies in systems with similar properties for confirmation or refutation of hypotheses. For this reason at least, ecologists of the Pacific slope will find this book valuable. It reports the results of a multi-investigator long-term study on the effects of fire on the 373 ha Swartboskloof catchment in the Jonkershoek Valley near Cape Town. The site is dominated by fynbos, the species-rich analog of chaparral. Though different in many ways from chaparral, it is similar in the importance of fire to ecosystem processes. Like oak woodland, the forest that occurs at the site is restricted to narrow bands along the larger drainages.

The purpose of the study was to understand how fire affects processes in the catchment landscape at the population, community, and ecosystems levels. The research design was straightforward. Studies began well in advance of a management burn conducted in 1987 and for the most part the analyses involve before and after comparisons and careful description of post-fire recovery. Experimental manipulation was also used in moderation, for example exclusion plots in a herbivory study, and cutting treatments to explore the stimulus for flowering by geophytes; but this is not the place to look for innovative approaches for whole ecosystem manipulative experimentation.

Coverage is thorough. Three introductory chapters describe the topography, geology, climate, and biota, including an entire chapter on fuel properties, as befits a book centering on fire. These chapters, plus accompanying pictures, provide a good introduction to those unfamiliar with fynbos. Subsequent chapters consider forest-fynbos relations, coexistence and comparative life history and physiology of post-fire seeding and sprouting shrubs, fire stimulated geophytes (*Watsonia*), the exotic invasion of fynbos, the effect of small mammals, aspects of ant ecology, sediment yield and non-wettability, chemical budgets, soil microorganisms, and a final summary.

Students of fire-prone ecosystems and particularly of Mediterranean vegetation, will find much of interest in the volume, as will those concerned with how catastrophic events determine ecosystem properties. One conclusion is that catastrophe does not always mean drastic change. The fire had little effect on the overall catchment nutrient budget and sediment production. Before and after comparisons (using statistical methods some would criticize) showed a large increase only for potassium, a small increase for nitrate, and no change for all other ions measured. The authors attribute this to rapid uptake by resprouting shrubs and the filtering effect of the forest vegetation that lines the larger drainages. Microbial populations, though initially depleted by the burn, also recovered rapidly.

In contrast, change wrought by fire is the cornerstone of the argument made by Richardson and Cowling to explain the susceptibility of fynbos to invasion by exotic woody species, particularly Australian *Acacia* and *Hakea,* and California and Mediterranean pines. They believe that the populations of native fynbos shrubs fluctuate in response to variation in fire timing and intensity. They argue that in pristine vegetation, there is coexistence mediated by stochastic variation. Fire-related crashes of local populations create windows of opportunity that are exploited by the expansion of competing populations and the temporary invasion of more dispersible natives. The exotics violate the rules of this stochastic game because unlike natives, they are

both readily dispersed and less subject to local extinction because of vegetative vigor, early age at first reproduction, and high seed production. They hypothesize a kind of ratcheting effect in which the less variable populations of invaders expand at the expense of the more variable natives.

A specific case of coexistence that continues to intrigue ecologists is the coexistence of sprouting and non-sprouting shrub populations. The basic problem is to explain why the sprouters that hold their ground don't exclude those dependent on seeds. The problem is explored in detail in two chapters. The idea that there are counterbalancing advantages is an obvious general explanation. The Swartboskloof studies both support and refute particular aspects of this theory. Contrary to the expectations of some, Smith et al. failed to find that the two groups of species differed significantly in physiological traits. But they also found that within Swartboskloof the dominance of sprouting species increased with increasing soil moisture. The same mixed bag of affirmations and refutations resulted from comparisons of two species of sprouting and non-sprouting *Protea* species. As predicted from allocation theory (and common sense), the seeder established significantly more seedlings per parent plant. In common with similar chaparral intergeneric comparisons, they found that adult mortality was lower and decreased with age in the sprouter, whereas mortality was higher and tended to increase with age in the seeder. Surprisingly, no differences were found in seedling mortality. Overall though, the importance of catastrophe in explaining coexistence was supported by the conclusion that seeders overcame the greater longevity of the sprouters because of a greater capacity for population expansion after the fire.

The dominance of shrubs on the site is an anomaly that gets considerable attention. With 1500 mm precipitation, tree-dominated vegetation would be expected. Data presented make a convincing case that forest species can establish and grow in fynbos. But forest species are more sensitive to fire and less able exploit post-fire conditions, thus leading to the conclusion that fire is the primary factor preventing a succession toward forest.

This combination of interesting natural history with frequent allusions to data from other regions is a strength of the book. Students of Mediterranean ecosystems in particular will find it of interest. Together with the recently published "Ecology of fynbos" (Oxford University Press, Cape Town, R. M. Cowling, Ed.) we have an excellent summary of current knowledge against which to test the generality of our ideas about the function of Mediterranean-climate shrublands.

Finally I have a mundane but important criticism relevant to resilience, not of ecosystems, but of the book itself. Even before this review was complete page 275 had fallen out of my copy and page 179 clung by less than a cm. We expect our second-hand Barbara Cartland paperbacks to do this, but a new and pricey Springer hardback should be better able to take abuse.

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Note: I have learned that Springer has rebound all remaining copies; therefore books purchased after this review appears should be sound.

The Jepson Manual: Higher Plants of California. By James C. Hickman (ed.). 1993. University of California Press, Berkeley. xvii + 1400 pages. ISBN 0-520-08255-9.

With over 5800 vascular plant species growing outside cultivation, California has the most diverse flora of any state—perhaps even any floristic region—in the U.S. Preparing a manual for such a large flora is a monumental task. Making that manual useful not only for professional botanists but for virtually anyone with a serious interest in plants may seem impossible. That, however, is just what the team at the Jepson Herbarium, led by the late Jim Hickman and Larry Heckard, has attempted. They succeeded remarkably well.